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TRANSACTIONS

OF THE

ROYAL SCOTTISH ARBORICULTURAL SOCIETY.

LIEUT.-COLONEL F. BAILEY, F.R.S.E.,
HONORARY EDITOR.

ROBERT GALLOWAY, S.S.C.,
SECRETARY AND TREASURER.

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PAGE

XII. Address delivered at the Forty-seventh Annual Meeting of the Society, 31st January 1900. By the Right Hon. the EARL OF MANSFIELD, President of the Society, ... 157

XIII. British Forestry and its Future Prospects. By JOHN NISBET, D.Œc., 161

XIV. Address delivered at the General Meeting, 7th August 1900. By ALEXANDER MILNE, Vice-President of the Society, . . 178

XV. Douglas Fir on the Durris Estate. By ALEXANDER YEATS, Assistant Forester, Durris, ... 185

XVI. Description and Sketches of Lever Appliance. By JAMES RODGER, Forester, Morton Hall Estate, Norwich, ... 189

XVII. Working Plan for the Right Honourable the Earl of Selborne's Blackmoor, Bradshott, and Temple Woods in Hampshire. Prepared by JOHN NISBET, D.Œc., F.S.I., ... 193

XVIII. A Visit to Dr Schlich's Forests at Mirwart. By Colonel F. BAILEY, ... 241

XIX. Forest Operations in County Galway, Ireland. By Dr SCHLICH, 249

XX. The International Congress of Sylviculture. By J. S. GAMBLE, C.I.E., M.A., F.R.S., ... 262

XXI. A Battle with Beetles. By JOHN CLARK, Forester, Haddo, Aberdeen, ... 274

XXII. Notes on the Importance of Tree Seed-Testing. By JOHANNES RAFN, Skovfrökontoret, Copenhagen, Denmark, . . 277

XXIII. Damage to Woods and Agricultural Crops by Sparks from Railway Engines. By Colonel F. BAILEY, ... 289

XXIV. The Annual Excursion in 1900 to Clandeboye, Baronscourt, and Castlewellan, in Ulster, ... 294

REPORTS BY THE HONORARY SCIENTISTS, ... 306

NOTES AND QUERIES:—Damage to Pine Woods by Crossbills—Systematic Nomenclature of Trees—A Survivor of the Black Wood of Rannoch—Extraction of Tree-Stumps—Death Duties and Timber Planting—The Tap-Root of the Larch—The Growing of Douglas Fir—Prices of Home-Grown Timber—The Nation's Timber Imports and Exports, ... 318

REVIEWS OF BOOKS:—"The New Forestry"—"Our Forests and Woodlands"—"Veitch's Manual of the Coniferæ," . . 329

OBITUARY NOTICE:—The late Daniel Dewar, Beaufort, . . 336

LIST OF MEMBERS, corrected to December 1900.

PROCEEDINGS OF THE ROYAL SCOTTISH ARBORICULTURAL SOCIETY.

PAGE

XXV. The Forestry Exhibition at Paris and Some of its Lessons. By J. S. GAMBLE, C.I.E., F.R.S., etc., ... 339

XXVI. The Outlook of the World's Timber Supply. By Dr W. SCHLICH, C.I.E., F.R.S., ... 355

XXVII. Insufficiency of the World's Timber Supply, ... 384

XXVIII. The Arboricultural Adornment of Towns. By R. C. MUNRO FERGUSON, M.P., ... 388

XXIX. The Valuation of Woods or Plantations for the Purpose of Transfer. By JAMES PEARSON, Strabane, Brodick, . 398

XXX. Further Notes on Tree Seed-Testing, 1900-01. By JOHANNES RAFN, Skovfrökontoret, Copenhagen, Denmark, . . 407

XXXI. Forestry in Kent and Sussex. By DAVID A. GLEN, Forester, Bedgebury Park, Goudhurst, Kent, ... 414

XXXII. A Visit to German Forests. By FRASER STORY, Assistant-Factor, The Glen, Innerleithen, ... 424

XXXIII. Hints on the Training of Foresters. By R. C. MUNRO FERGUSON, M.P., ... 444

XXXIV. Manufacturing Timber. By JOHN M'PHERSON, Manufacturing Forester, Novar, ... 448

XXXV. Notes on Forest Work. By GEORGE U. MACDONALD, Forester, Raith, ... 451

XXXVI. Notes on the Forests of Norway. By Colonel F. BAILEY, . 458

XXXVII. Report on the Effects of a Hailstorm to Growing Timber Crops. By HUGH C. SAMPSON, B.Sc., ... 467

XXXVIII. Of Damage done to Trees by the Shale Industry. By a CORRESPONDENT, ... 470

XXXIX. The White American Spruce (*Picea alba*) as a Wind-Mantle. By JOHN F. ANNAND, Overseer, Haystoun Estate, Peebles, 473

XL. Forestry Section of the Highland and Agricultural Society's Show at Inverness, July 1901. By D. F. MACKENZIE, F.S.I., Mortonhall, Midlothian, ... 475

XLI. Report of Deputation from the Society received by the Right Hon. R. W. Hanbury, M.P., President of the Board of Agriculture, 9th October 1901, ... 479

XLII. Report showing the Financial Results of the Cultivation of Timber. By D. F. MACKENZIE, F.S.I., Mortonhall, Midlothian, ... 494

XLIII. Abstract of Returns of Prices of Home-grown Timber in 1901. By D. F. MACKENZIE, F.S.I., Mortonhall, Midlothian, . 504

XLIV. The Annual Excursion in 1901, ... 507

NOTES AND QUERIES:—Sparks from Engines—Impregnation of Timber in an Open Boiler—Scottish Tree-Seeds for Norway and Sweden—An Arboricultural Society for Ireland—The Cape of Good Hope—Teaching of Forestry in the Provinces—Edinburgh University Forestry Class—The Menzies Fir—The Objects, Methods, and Results of Measurements of Girth-Increase in Trees, ... 524

PROCEEDINGS OF THE ROYAL SCOTTISH ARBORICULTURAL SOCIETY.

Yours sincerely,
Theodore Thum.

TRANSACTIONS

OF THE

ROYAL SCOTTISH ARBORICULTURAL SOCIETY.

I. *Address delivered at the Forty-sixth Annual Meeting held on 24th January* 1899. By Colonel F. BAILEY, President of the Society.

My term of office has now drawn to a close, and I desire to express my best thanks to the Council and Officials of the Society for the cordial support they have always given me, which has rendered my duties as President both light and agreeable. But before handing over office to my successor, I propose, with your permission, to offer a few remarks on some of the more important of the matters that have recently occupied our attention.

It is a common saying that woods here will not pay, though it is well known that in other countries they can be made to yield a handsome profit. It is said that our soil and climate are unfavourable to sylviculture; but no one has made clear to me what is wrong with either the one or the other. I have, however, heard it remarked that we have not sufficient sunshine for the development of close-grown crops; but I am not aware that we are worse off in this respect than the countries surrounding the Baltic Sea, with its northern and eastern extensions, whence we annually import a large proportion of the timber we use, which has obviously been grown in densely stocked woods.

It is a well-known fact that woods, and especially woods of fir, pine or larch, will develop vigorously on soil of very poor quality. I know forests in France, on the shores of the Bay of Biscay, growing on soil the mineral constituents of which, to the extent of 94 or 95 per cent., consist of pure flint sand; yet they produce pine timber of large dimensions, and large profits are made on the resin extracted from the trees. Is the soil that we complain of worse than that? Of course on our higher uplands, with their

CONTENTS OF VOL. XVI.

The Society, as a body, is not to be considered responsible for any statements or opinions advanced in the several papers, which must rest entirely on the authority of the respective authors.

PAGE

I. Address delivered at the Forty-sixth Annual Meeting held on 24th January 1899. By Colonel F. BAILEY, President of the Society, ... 1

II. The Bo'ness Pit-Wood Trade. By Colonel F. BAILEY, . . 9

III. Pure Forests and Mixed Forests. Lecture delivered on 24th February 1899, by Sir DIETRICH BRANDIS, K.C.I.E., LL.D., late Inspector-General of Forests, India, ... 13

IV. Plan or Scheme of Management of the Woods of the Novar Estate for twenty-five years, from 1899–1900 to 1923–24. By Colonel F. BAILEY, assisted by JOHN J. R. MEIKLEJOHN, Factor, JOHN D. B. WHYTE, Assistant-Factor, and WILLIAM MACKENZIE, Forester, ... 25

V. Note on Raith and Novar Working Plans. By R. C. MUNRO FERGUSON, M.P., ... 96

VI. Thinnings. By M. BROILLIARD, ... 100

VII. On the Influence of Different Degrees of Thinning on the Growth of Beech. By A. C. FORBES, Wood Manager, Bowood, Calne, 116

VIII. Letter from E. JÄGMÄSTARE ELIS NILSON, Stockholm, Sweden, regarding his visit to Larch-woods in Scotland, . . 123

IX. The Ash (*Fraxinus excelsior*) and its Cultivation. By JOHN NISBET, D.Œc., F.S.I., ... 128

X. The late Mr Malcolm Dunn, Dalkeith. By W. MATTHEWS GILBERT, Edinburgh, ... 132

XI. The Annual Excursion in 1899 to Beaufort, Dunrobin, Dornoch, and Skibo, ... 138

REPORTS BY THE HONORARY SCIENTISTS, ... 146

PROCEEDINGS OF THE ROYAL SCOTTISH ARBORICULTURAL SOCIETY.

annual exports of several of the countries from which we draw our main supplies largely exceed the amount which their forests annually produce. In other words—in order to maintain their present high rate of export, they are cutting much more than they grow, and are thus dipping deeply into the wood-capital, which is their producing agent—the layer of their golden eggs! It is not difficult to see that this process cannot be indefinitely maintained. Indeed, experts are agreed that present over-consumption is undoubtedly leading to a wood-famine, or at best to a scarcity, which cannot fail to cause a rise in prices in the comparatively near future; and it will be to our advantage to place ourselves, as soon as possible, in a position to profit by such a rise whenever it may occur. It would evidently be to the interest of owners of land that we should occupy this position; and it would be no less to the advantage of those who make it their business to manage wooded estates, and who might reasonably expect that the efficient management of a more profitable business would entitle them to an improvement in their position and prospects. But we cannot reckon on occupying this advantageous position unless a considerable proportion of our woods is organised on business principles. A larch tree requires seventy or eighty years to attain its most profitable dimensions; and if, at the expiry of that time, the crop is to be a complete one, composed of sound trees of full size, the wood must be managed with this end in view throughout the entire period of its growth. Such management is best secured by means of a plan or scheme, called a Working Plan, which defines the object aimed at, lays down the general outlines of the means by which it is to be attained, and usually prescribes in some detail the work to be done during the first few years. Guided by such a plan, it is possible to avoid the changes too often introduced by new proprietors or managers, to the great prejudice of their woods, which, when thus treated, frequently present a disappointing appearance at the stage of growth when thinnings might be expected to yield a considerable profit.

Land devoted to the production of timber ought to be made to yield up to its full capacity, consistently with the provision of a sustained out-turn; but this cannot be looked for unless the factory contains a full complement of able-bodied and efficient workmen; or, in other words, unless the ground be fully stocked with healthy trees, each of which is adding duly to his own bulk

by the accumulations of successive seasons' growth. Again, the cost per cubic foot of fencing, working and controlling is less in fully stocked woods than in woods carrying a thin crop. Then, in regard to the fellings which the proprietor of the day is entitled to make. If his woods are fully stocked, he is evidently justified in taking, year by year, the amount of wood annually produced on his estate, a process which will leave the growing or producing stock undiminished. Indeed, he ought to take this amount, in order to nurse the market and avoid accumulations of growing stock, which are often inconvenient and unprofitable. But if he is without a plan, he is ignorant of the amount annually produced, and consequently of the number of trees it represents, or the area it entitles him to clear; and this ignorance may lead either to crops of trees standing long after they have ceased to occupy the ground profitably, or to the detriment of the property by over-cutting. Then again, as regards the markets, the regular out-turn of a certain fixed quantity of produce of a well-known class is sure to attract buyers, and thus to improve prices; while, at the same time, it encourages the establishment of wood industries in the neighbourhood, and thus secures the profitable disposal of inferior classes of wood for which there would otherwise be no local demand, and which it would not pay to export to distant markets. A regular out-turn, under a settled plan, further renders it possible to reduce the cost of transporting the timber to convenient sale-depots by the use of mechanical appliances, which could not be adopted for work conducted here and there in haphazard fashion, a method which, it may be observed, involves the maximum of cost; and a recognised plan of operations enables all work to be laid out, and sales to be arranged, in advance. All these things tend to increase receipts, to reduce outgoings, and thus to enhance the profit derivable from the business.

About 800 acres of pine and fir woods at Raith have recently been brought under the operation of a plan such as that above indicated; the object of management being the conversion of the produce into pit-wood, for which a practically unlimited demand exists in connection with the local coal-mines. A detailed examination of these woods has disclosed an almost complete break of twenty years in the work of planting; and this has indicated their classification into the "older" and the "younger" woods. The main feature of the scheme consists in the distribution of the fellings of the woods of the older class over

the number of years that must elapse before the oldest of the younger woods, now seventeen years of age, attain suitable dimensions. Here, in future, work will be carried out in regular fashion, the results of management being clearly recorded in books specially prepared for the purpose. The estimated profits much exceed those hitherto realised, this being due to the fact that on this part of the estate profit is now to be the sole object aimed at,—sporting and æsthetic considerations will occupy a subordinate place; but it should be added that the market rates are here exceptionally favourable, and that every stick grown can be either used on the estate or sold. Probably there are not many estates in Scotland so fortunately situated in this respect as Raith.

The proprietor has most kindly permitted the woods of the Pit-Wood Working Circle to be freely used for educational purposes; and although this fact does not relieve us from the duty of urging on the Government the necessity of establishing a small State Model Forest, our immediate requirements in the matter of a practical training-ground for students are effectually met. A Working Plan for the Novar woods is now under preparation on lines similar to those of the Raith plan; and the provision of a bursary to enable a student desirous of becoming a practical forester to attend the University class has been mentioned in the Report of the Council. The preparation of the Raith and Novar Working Plans, and the inauguration of this bursary, are important events of a most encouraging character. I feel confident that the start now made will have far-reaching effects, and will result in an unchallengeable affirmative answer being given to the question, "Can woods in Scotland be grown profitably?"

It is now my pleasing duty to propose that the Earl of Mansfield be elected as my successor. In doing so, I need not say more than that his ownership of extensive woodlands secures his interest in our work, and renders him an eminently desirable President of our Society. We esteem it an honour that he should be willing to undertake the duties of the chair.

At the close of the business meeting, Colonel Bailey gave a short address on the timber resources of Canada and the United States, and then showed a number of lantern slides illustrating a journey in Canada which he had made in the autumn of 1897. His remarks were to the following effect:—

The United Kingdom is the world's greatest importer of timber; we take something like £18,000,000 worth annually, and the figure is rapidly rising. From four of the countries that supply us we obtain produce to the value of £14,000,000, viz.:—from Sweden, £4,000,000; from Russia, £4,000,000; from Canada, £3,500,000; and from the United States, £2,500,000. Let us consider for a moment the position in Canada and the United States, which together provide us with one-third of our annual requirements.

As regards the former country, we have copious information in Johnson's "Report on the Forest Wealth of Canada," 1895. The forests are estimated to cover an area of 1,250,000 square miles, or about forty-two times the area of Scotland with all its islands. This is ample enough to grow wood for home consumption, as well as to supply the United States and the British Isles, and one might almost add, the world at large. But a considerable proportion of this vast area does not now contain marketable timber, and the remainder is not under conditions which will enable it to yield a permanent supply. There are already signs of exhaustion visible in the reduced size of the logs we receive as compared with those sent over a score or so of years ago. The White (Weymouth) pine of marketable size will have disappeared before many years have elapsed, while the young natural crops are being destroyed by fire; and the position of the spruce and the Douglas fir is not much better.

Fire is the great destroying agent, and there can be no doubt that although the uncontrolled rapacity of the lumberman is answerable for a good deal, fire consumes, or irretrievably damages, a vastly greater share of the forest wealth of the Dominion. Settlers in the "back woods" are responsible for perhaps the greater part of the destruction by fire. They get grants of forest land, covered with huge trees, which, so long as they stand or lie on the ground, form an effectual impediment to its cultivation. They must clear the ground; and to cut down and drag away timber for which there is no market is a practical impossibility for them. But the highly resinous pines and firs quickly succumb to the fierce flames which soon follow the kindling of a fire; and in this way the settler is able, without the expenditure of time and superhuman labour, to rid himself of a crop of magnificent timber, which represents to him nothing but an otherwise immovable impediment to the development of the "claim" for the support of himself

and his family. Unfortunately, the evil does not stop here; for the fire once lighted gets at once entirely beyond his control, and it burns on until stopped by a river, a sheet of water, an area already burnt, or some other obstacle to its progress. Railway lines, again, have led to damage on an enormous scale. To facilitate their construction through the dense primæval forests, uncontrolled burning has been freely resorted to; and during the hot and dry season of the year sparks from engines annually continue the work of destruction; so that when travelling by rail through long stretches of country which it may take hours to traverse, one sees nothing, as far as the eye can reach, but the bare, blackened stems of pine and other trees, under which a second growth, usually of inferior species, is struggling up.

If Canada is to secure provision even for her own future wants, she must look to her resources before it is too late to do so. She should at least establish extensive reserves, and effectually protect them against fire The present area of reserved forest is insufficient, and the measures taken to preserve it from burning are wholly inadequate. To the traveller across the continent by the Canadian Pacific Railway, the thought naturally occurs as to what effect the wholesale destruction of forests formerly covering the catchment basins of the great lakes may have on their water-levels. This is an important consideration, in view of the great inland water-way which they form.

In the United States the area reserved and effectually protected formed recently but a very small fraction of that needed for the permanent supply of the *existing* population. The States appear in the returns as exporters to us, but they take from Canada something like twice the amount of their shipments to this country; and there is no doubt that before the lapse of many years they will require and take all that Canada will then be able to spare. Whenever this situation arises, we shall have to look elsewhere for the £6,000,000 worth of timber that now comes to us across the Atlantic, or to go without it; and this fact alone is sufficient to warrant the opinion that a rise in the price of imported timber is to be confidently anticipated, and to give ground for urging the desirability of planting up a substantial portion of our own waste land with as little delay as possible.

At the close of these remarks Colonel Bailey exhibited his lantern slides.

II. *The Bo'ness Pit-Wood Trade.*[1] By Colonel F. Bailey.

The importation into the port of Bo'ness, which commenced about thirty-five years ago, of pit-wood for use in Scottish mines, rose last year to 116,991 loads, representing rather more than that number of tons of wood.

For the first few years the timber was carried in small sailing vessels of from 150 to 200 tons. These took in their cargo at Christiansand, Christiania Fiord, and other ports on the south-western coast of Norway, whence freights were low, and the vessels carried back Scotch coal. Somewhat later, shipments began in sailing vessels of larger size from western Swedish ports, chiefly from Göttenborg, the terminus of the trans-peninsular canal, down which much pit-wood was, and still is, floated from the shores of lakes Wener and Wetter. Sailing vessels up to 600 or 700 tons burden still convey large cargoes of wood from Norwegian and western Swedish ports; but steamers up to 1500 tons burden are for the most part now employed in the Göttenborg trade. Pit-timber comes over chiefly in the form of round props, cut to lengths of from 2 feet to 8 feet, and having a minimum diameter at the small end of 2½ inches for the shortest and 8 inches for the longest pieces. Pit-wood from the south-eastern coast of Sweden is, however, as a rule imported in the form of poles from 9 or 10 feet to 35 feet in length, with a minimum top-diameter of 3 inches; but a small consignment of heavier poles, up to a top-diameter of 6 inches, also reaches us from that region. Much of this longer timber is carted in by farmers from woods growing at distances up to ten miles from the loading ports; and large quantities of the shorter props are carted, sledged, or floated down to Swedish ports on the shores of the Gulf of Bothnia; while, during the last fifteen years, immense cargoes of produce of this class have been shipped from Russian ports on the northern shores of the Gulf of Finland, and on the eastern shores of the Gulf of Bothnia.

In both Norway and Sweden, growing forests from which mine-timber is still obtained are becoming as scarce near the sea-coast as they are on the banks and shores of rivers and lakes; and the principal shipments are now made in steamers from Finland, where vast forests exist, but where railways have not yet penetrated,

[1] Written from information kindly supplied by Mr D. K. Harrower, of the firm of John Denholm & Co., pit-wood importers and timber merchants, Bo'ness.

the wood having to be brought to the coast on carts or sledges, or floated down by river. How long these supplies may last cannot at present be estimated; but in the absence of an organisation limiting the quantity exported to that which the yearly growth of the forests can replace, and providing for the restocking of the ground by planting and sowing, or by duly protected natural regeneration, it is easy to see that the present rate of export cannot be permanently maintained.

Numerous cargoes of wood of a class which used formerly to be discarded as waste are now floated by canal to St Petersburg, whence they are shipped to Bo'ness and other ports as pit-wood; while large consignments of props in 7 feet to 8 feet lengths are brought over from the Gulf of Riga, and also from Stettin and other German ports. The vessels employed in this trade usually carry back coal.

The wood lying in the port of Bo'ness is chiefly spruce; but there is also a proportion of Scots fir, which, being more resinous, is considered to possess greater durability. The timber has been grown in dense forests, and has therefore narrow annual rings, [illegible] comparatively free from knots, while it tapers but little, Canadian [illegible] [illegible]ost part been barked. It is, generally speaking, effect the wholesa[illegible] the round"; but logs of 6 inches and [illegible] basins of the g[illegible] longitudinally into quarters and [illegible]tant consider[illegible] form.

[illegible] imported props, and the [illegible] area reserve[illegible] them "*ex* ship," are as [illegible]ll fraction [illegible] population.

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[illegible] ited his

The usual dimensions of the sho[illegible] prices per 100 linear feet now charged [illegible] follows:—

Top-Diameter. Inches.	Lengths Feet	Prices 100 Linear Ft. s. d.
2½	2, 2½, 2¾, 3, 3½, 3¾, 3¾, 4	[illegible]
3	3½, 3¾, 3¾, 4, 4½, 4½, 5, 5½, 6	[illegible]
3½	3¾, 4½, 4½, 5, 5½, 6, 6½, 7	[illegible]
4	5, 5½, 6, 6½, 7, 8, 9, 10	[illegible]
4½	5½, 6, 6½, 6¾, 6¾, 7, 7½, 8	[illegible]
5	5½, 6, 6½, 6¾, 6¾, 7, 8, 9, 10	[illegible]
5½ } 6 }	6, 6½, 7, 8, 9, 10	[illegible] 7 0
6½ } 7 }	6½, 7, 8, 9, 10	[illegible] 8 0 [illegible] 9 0
7½ } 8 }	7, 8, 9	[illegible] 10 0 [illegible] 11 0 [illegible] 12 0

For long pit-wood of 3 inch top-diameter, running from 10 feet to 35 feet in length (average 15 feet to 16 feet), the price per 100 linear feet is now 4s. 6d.

The rates above quoted represent from 5¼d. to 5¾d. per cubic foot "*ex* ship," to which rate must be added from ½d. to ¾d. per cubic foot for shore dues, loading, and depot expenses, bringing the cost to purchasers at the port up to from 5¾d. to 6½d. per cubic foot. Railway freight to the mines forms, of course, an additional charge.

The Transactions of the Mining Institute of Scotland, vol. xx., part 2, 1898, contains an interesting paper by Mr George L. Kerr on "Timbering and Supporting Underground Workings." As regards the species of wood used, the author says: "The different kinds of wood used for mine-timbering in Great Britain are larch, Scotch fir, Norwegian pine, and sometimes oak and beech. In ordinary timbering Scotch fir is largely used, especially where the timber does not require to be heavy, and where the pressure is not great; but in drawing and main roads that have to be kept open for some time, larch has been found to be most efficient, both as regards durability and economy. Any woods that are long-grained and elastic, and will yield to thrust, are suitable for mine-timber, because props of such woods often serve the purpose for which they are used, even when partially fractured. Beech or oak props are short-grained, more or less brittle, and break off short under crushing strain. Their great weight, as compared with other woods, and the consequent difficulty in handling them, is against their use underground." He states that the cost of timber per ton of coal raised varies in different districts and different collieries from ½d. to 9d., according to the depth from the surface, the thickness of the seam, the nature of the roof, the inclination of the seam, and the method of working. He gives the crushing strain for ordinary larch props as 1½ to 2 tons per square inch, "according to the age of the wood and the seasoning that it has undergone." If the timber be cut when green, and allowed to season or dry in a gradual manner, it is said to be 49 per cent. stronger than "ordinary pit-props." The writer concludes his paper with the following remarks on the preservation of timber:—"Timber required for use underground, or indeed anywhere, should be cut in winter, when the wood has little sap in it, because the sap ferments and causes rapid decay; wood should also be well seasoned before being used; and if these two

points are carefully attended to, they constitute frequently the only preservative that the timber requires. The bark should also be removed before being used underground; and if this be done, there is less liability for the timber to rot, and the decay, when it sets in, is more easily detected." Creosoting has, he observes, the disadvantage that it renders the timber more inflammable, while it also diminishes its strength.

The dimensions and rates above given may prove a useful guide on estates where the preparation of pit-wood has not yet been attempted. On properties which are favourably situated, this trade might become very profitable, as, owing to the shortness of the rotation (which, in the case of pines and firs need not exceed thirty-five or forty years), the returns are comparatively early and the risk is proportionally reduced; while, up to that age, dense crops, even of Scots fir, can be maintained; and there can be produced, on each acre of ground, a large number of the tall, straight, clean and cylindrical poles, such as will yield the best possible class of timber for use in mines. Props sawn from larger stems of the rough quality grown in open crops of greater age, are not nearly so much liked, on account of the splinters from them which injure the miners' hands.

Even where the production of pit-wood does not form the main object of management, it is likely that, in many localities, the thinnings made between the ages of about thirty to forty-five years or more, in coniferous woods with a higher rotation, may be profitably disposed of for this purpose; and crops which have been destined to stand for a longer period, but which are found at these ages in an unpromising condition, might, in some cases, be cleared off and sold to the pit-wood merchants.

When considering the relative merits of the Scots fir and the spruce for use in mines, it should be remembered that, although the wood of the former is more resinous, and consequently more durable than that of the latter, spruce trees grown in dense crops, having narrow annual rings, yield timber of a much more durable quality than is ordinarily raised in open woods; and that the tendency of the spruce to throw out strong side-branches in youth being much less than that of the Scots fir, clean poles can be more easily grown of the former than of the latter species. At the same time, owing to the shade-bearing properties of the spruce, a considerably larger number of stems of that tree can stand in a healthy condition on an acre of ground than in the case of the light-loving Scots fir.

III. *Pure Forests and Mixed Forests.* Lecture delivered on 24th February 1899, by Sir DIETRICH BRANDIS, K.C.I.E., LL.D., late Inspector-General of Forests, India.

It is a great honour to be allowed to speak here for the first time before the Royal Scottish Arboricultural Society. As early as 1873 they did me the great honour of nominating me an Honorary Member of the Society. That was an honour which I value very highly. I have since then repeatedly sent contributions to the *Transactions* on general matters which, I was told, would interest your members; but I have not yet had an opportunity of speaking before you in this beautiful town of Edinburgh.

There are plants and trees which by nature, by their individual character, like to live in company of their kind. We call them "gregarious." There are other plants and trees which you find only scattered. Among the gregarious plants you will at once remember the heather, the flowers of which in August and September ornament your hills. It covers large areas, and where you have the heather there is little else besides. Among the trees you will at once remember the beautiful forests of Scots Pine at Rothiemurchus, and on the hills near the Strathspey valley. Those of you who accompanied Professor Schwappach on your tour through the forests of Northern Germany will recollect the extensive areas of Beech forest in that part of the country. Other trees however—for instance the Maple, the Sycamore, or the Ash—you will never find covering large areas by themselves.

Concerning the Oak, I must, with your permission, enter a little into detail. The Oak, which is commonly known as the British Oak, foresters in Germany and France classify as two distinct species—*Quercus pedunculata,* with the acorns on long stalks; and *Quercus sessiliflora,* with acorns on short stalks. The former, in Germany, grows in the plains, often on low ground along the banks of rivers, and here it forms pure or nearly pure forests, with an underwood of Hazel, Bramble, and other shrubs. *Quercus sessiliflora,* on the other hand, mostly grows on the hills, and, as a rule, in company with the Beech, the Hornbeam, or the Silver Fir. It is very remarkable that these two kinds of Oak, which are so nearly related to each other, that by English botanists they are generally regarded as belonging to one species, should be so different in their habits.

Doubtless you are disposed to ask the question, What makes

certain trees gregarious in their character, while others are only found scattered in forests of other trees? A complete reply to that question cannot be given at present, but perhaps we shall be able better to understand one of the factors which govern the habits of trees in this respect, if you follow me for a few minutes into a range of mountains called the Nilgiris, or Blue Mountains, which are situated in the peninsula of India. This mountain range is associated with the name of my dear late friend, Dr Hugh Cleghorn, who repeatedly has been the President of your Society, and whose services to Indian Forestry cannot be spoken of too highly.

These mountains have probably received their name from a shrub, a species of *Strobilanthes*, which covers extensive areas on the slopes, and which bears a profusion of blue flowers. Like this one, other species of *Strobilanthes* also are gregarious, some covering large areas in the open, while some form the underwood in the forest. It is a remarkable fact, that most of the gregarious species do not flower annually, but in periods, according to the species, of from five to ten years. There is an underground rootstock or rhizome, which annually sends up leaf-bearing stems. When the rootstock has attained a certain age, flower-buds instead of leaf-buds are formed on the branches, the plant is covered with flowers, and after the seeds have ripened, it dies. There seems to be a certain coincidence between gregarious habit and periodical flowering. In a marked manner this shows itself in the Beech, and in several coniferous trees, which are eminently gregarious. There are no large Beech forests in Scotland, and the circumstance may not be as familiar to you as it is to foresters on the Continent, that the Beech does not bear a good crop of seed every year, but that mast years occur at irregular intervals of from five to ten years. Those trees and shrubs, which flower periodically at regular or irregular intervals, on such occasions produce such an abundance of seed that the thickets of young plants kill out everything else, and thus grow up as pure woods.

These remarks must suffice by way of introduction. The question of gregarious and sporadically growing trees is a very large one, which may well claim the interest of foresters and botanists.

I desire now to draw your attention to several large areas stocked with pure forests in Germany. You will, I feel sure, excuse my speaking of the forests of my own country. In the first place, I am more familiar with them; and, in the second

place, the forests of Germany are so vast, so varied, and are managed in a manner so methodical and skilful, that the study of their management is exceedingly instructive.

In the first instance I wish to mention the kingdom of Saxony. That State, which extends on both sides of the Elbe river, is one of the most densely peopled in Germany. It is a small country, covering only 5700 square miles, which is less than the mean area of a district in the Presidency of Madras. There are 3,787,688 inhabitants, or 660 souls to the square mile. You would think that in Saxony every inch of land would be required to grow corn and cattle fodder, for it is a highly industrial, a manufacturing and mining country. Nevertheless it has no less than 26 per cent. of its area under forest, and it is this area of well-managed forests which, as a matter of fact, contributes largely to the prosperity of that country so densely populated. The State forests of Saxony comprise 435,000 acres, divided into 108 ranges. Each range is under the charge of an executive officer, and the mean area of a range is 4000 acres. That is the area which experience in that country has shown can most advantageously be managed by one man. These executive officers have received the very highest practical and scientific education. Above them are a number of high controlling officers, who are chosen from among those executive officers who have distinguished themselves by efficiency and ability.

A large area of these forests is situated on the northern slopes of the mountain range which divides Saxony from Bohemia. This mountain range, which rises to an elevation of 3000 feet, is known as the Erzgebirge; and the forests on the Erzgebirge are the largest and most important of the State forests of Saxony. They consist almost entirely of pure Spruce. However, it was not all pure Spruce formerly, but gradually, through the system of management adopted in that country, they have been converted into pure Spruce forests, because these have been found, in the circumstances, to be the best paying woods.

The management is exceedingly simple—it is clear cutting and planting, the system to which in many parts of Scotland you are accustomed to. The clearances, however, are made with the greatest care, so as to guard against damage. It is a hilly country, consequently the action of storms and heavy winds is often very dangerous. You know something of the action of storms, for a few years ago a very large area of fine forest was thrown down in

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annual increase bear to the capital value of the forest—soil and growing stock.

You will readily understand that this question opens up a series of intricate problems, the study of which to a practical Scottish or English forester may seem a useless waste of time. Compared with an old wood, the selling value of a plantation which has attained the pole stage, say at the age of from thirty to forty years, is small. At that period of their life trees grow with great rapidity, and the annual increment represents a high percentage of the capital value of the forest. As the trees grow older the value of the timber increases, and the annual increment naturally represents a steadily diminishing percentage on the capital value of the soil and the timber crop standing on it. At last a stage is reached at which it would be more profitable to cut the wood and to invest the proceeds in Government securities, at say 3 per cent., than to let the forest stand and grow older.

In the State forests of Saxony, and in large areas of woodlands on private estates in Germany, which are managed on a similar system, the general rule is to cut the wood when that stage has been reached, that is when the annual increment falls below 3 per cent. on the capital value of the forest. Experience has shown that when Spruce forests in Saxony are over eighty years old, the proportion of the annual increment to the capital value of the forest has fallen below the rate at which money can be invested in Government securities. Hence woods that have attained the age of eighty years as a rule are cut. In that way these forests are managed, and the result, so far as money goes, is quite wonderful. The return of these pure spruce woods on the Erzgebirge, after deducting all outlay of whatever kind, is 32s. an acre. This is the average yield on an area of more than a hundred thousand acres. That is an instance of pure forests which I wished to mention to you.

But in spite of all precautions there are drawbacks. *First*, the wind plays havoc with spruce woods, when they are pure, to a much greater extent than is the case in mixed woods. *Secondly*, insects do an immense deal of damage. And here I may be allowed to mention a forest area in the kingdom of Bavaria, a much larger country than Saxony, but, like Saxony, exceedingly rich in forests, which, though as a rule managed on an entirely different system, are in splendid condition. Bavaria is not as densely inhabited as Saxony. South of Munich, not far from the

railway line which leads to Innspruck and across the Brenner Pass to Italy, there is a large area of Spruce forest, called the Ebersberger Park, which I visited in 1889. It is one compact mass, covering about 16,000 acres. At the time of my visit the outskirts of that Spruce forest were well stocked and in good condition, but in the interior every tree was bare; a dense forest of tall trees, all leafless, like a huge churchyard. This was the work of the caterpillar of a moth known as the Nun, *Liparis monacha*. In moderate numbers this insect is found everywhere in forests of the spruce and of the Scots pine, but at times, when in a certain locality the seasons during successive years have been favourable for its development, and less favourable for the development of its enemies, it multiplies in an extraordinary manner. The moths are white, they were swarming about like the flakes of snow in a snow-storm. You will ask why the outside of the forest was not eaten bare by the caterpillars. They dislike wind, and love snug comfortable places, hence they avoid the outside of the wood; and in a hilly country they avoid ridges and exposed peaks.

In the "Ebersberger Park" 4700 acres had been eaten completely bare, not a vestige of a leaf being left on the trees; and a further area of about 7400 acres was severely attacked. Similar damage had been done by the "Nun" in other large forest districts in Southern Germany and in Austria. The forest is the property of the State, and nothing remained except to cut the whole of the timber at once. To wait and to cut the trees gradually was out of the question. The timber would have deteriorated and the bark beetles would have multiplied to such an extent as to endanger the existence of other forests in the vicinity. The calamity was met with wonderful skill and energy. A branch railway was built from the main line into the heart of the forest, and small forest tramways were laid through the different compartments. Saw-mills were erected, and the whole of the timber was sold only a little below its usual market price, and the loss, therefore, was not considerable. The timber of that forest has a good reputation. A great deal of it went to Italy, and the smaller stuff was taken up by those excellent allies of the German forester, the paper-pulp manufacturers. The newspapers of the present day, *The Scotsman* and *The Times*, are, as you know, printed to a great extent on paper made of the spruce wood. Some people imagine that with the steadily growing con-

sumption of paper, the use of wood to make paper-pulp will entail the rapid destruction of forests. Nothing of the kind. The paper-pulp manufacturer is a most powerful ally of the forester. The small stuff in spruce woods can always be sold, and hence the forester can thin regularly and frequently, as he is sure of a market for his thinnings. In this way this huge quantity, which amounted to 53,000,000 cubic feet, was sold without difficulty. When all the timber had been disposed of, there remained the task of replanting the area, and this also has been accomplished successfully. All this required systematic and methodical arrangements. The heads of the Bavarian State forests determined to diminish the cuttings in other forests, so as to throw the demand for timber more upon those which had been devastated by the Nun.

You will now understand the great risk to which pure Spruce forests may at any time be exposed. There were beech trees here and there, which had grown up with the spruce, and the caterpillars had not touched them. The Nun had destroyed many other forests, and it was found that mixed woods, where the spruce was associated with beech in large quantities, or with Scots pine, had not been attacked by the insect.

I could give you many other instances of large areas stocked with pure woods, but I believe you understand now what the advantages and what the disadvantages are of pure forests. The advantages are that the management is simple and easy, for you have to deal with one species only. The disadvantages are that pure woods are more exposed to damage by wind and snow, by fungus, and by insects. The tendency therefore, you may readily imagine, in Germany at the present day is towards mixed forests.

Some of the finest mixed woods are those of Scots pine and beech, the beech forming the lower story and the Scots pine the upper story. Other woods consist of oak and beech, the beech again forming the lower story and the oak the upper story of the wood. Trees have to be studied with reference to the amount of light they require, and the finest mixed forests are those where you have a tree that requires much light forming the upper story —standards, you may call them—and a tree that requires less light in the lower story. You all know that the Scots pine requires a great deal of light. It does not grow up in the shade nor does the oak.

You also know that young thickets of Scots pine and young thickets of oak shade the ground well. The surface soil under

those thickets is loose, and this means that the air can readily penetrate to the roots. When the wood is thin the ground gets hard and is covered with grass, bilberries, or heather; and you know that a hard surface of the soil is not conducive to the happiness of a tree. However, as the thickets of oak and Scots pine get older and approach the pole stage, they thin out, and the foliage no longer is dense enough to shade the ground completely.

It is different with the beech and with other species that require less light and can support shade. Whether in the stage of thicket, of pole woods, or of mature trees, the ground remains shaded completely. Hence it is an advantage to have a lower story of beech under a forest of oak or Scots pine. Nothing is more beautiful than such a two-storied wood. The soil is being fertilised by the leaves of the beech; the standards of the oak or Scots pine grow much more rapidly; they clear themselves of side branches; they form long, straight, and regularly shaped boles, and their value as timber is much greater than that from a pure oak or Scots pine forest.

And that applies not only to the oak or Scots pine, but equally so to the larch, a tree which is justly regarded with much favour in Scotland. Still, if you look at the larch forests of the Alps, where it has its home, you will find that it grows best where it has a lower story of beech, and sometimes a lower story of other species. When the ground is covered by a lower story of a suitable species, the larch forms tall, clean stems, and it is much less exposed to attack by fungus or insects. Foresters in Scotland may find it useful to bear this in mind.

As already stated, in Germany the tendency at present decidedly is to encourage the growth of mixed forests; and these mixed forests, as I have said, as a rule consist of an upper story of trees that require a great amount of light, like the oak or the Scots pine, and a lower story, which in most cases is beech. But you may say this is an utterly impracticable proceeding, because beech can only be used as firewood, as a rule, and it fetches much less than the wood of either the oak or the Scots pine. So it is, and for the present I am content to leave you under the delusion that the German plan of mixed forests is utterly impracticable.

Let me now take you to that beautiful forest in Bavaria, which, if any of you have ever time to visit, it will well repay the trouble —the Spessart. It is situated in a large bend of the Main river, one of the principal tributaries of the Rhine. The underlying

rock is the red sandstone of the Trias, and the soil is mostly poor and sandy. From time immemorial the Spessart has been a forest country. Formerly it was the haunt of famous robbers; there were no roads and few villages. That forest originally consisted entirely of beech and oak. In old times the oak was mainly wanted to make wine casks for the produce of the vineyards near the Rhine and its tributaries.

When the trees were felled, they were split up into cask-staves, and these were taken down on mules or on men's backs. Large glass-works were in those days in the Spessart, the beech timber was burnt, and excellent glass was made of the potash and the pure sand, which collects in the stream beds. The demand at that time was greater for the beech than for the oak. In the soil and climate of the Spessart the beech grows with much greater vigour than the oak, and under ordinary circumstances the oak is apt to be suppressed and killed out by the beech. But the wholesale cutting of the beech for the glass-works in old times favoured the oak, and hence the great present value of these forests. The oak has grown up in company with the beech, and has formed fine tall stems.

I have selected the Spessart as an instance of mixed woods, because the principles which here regulate the cutting of the oak are entirely different from those by which, in the kingdom of Saxony, the management of the Spruce forests is governed. There is a large area in the Spessart of magnificent old oak woods. They are almost pure oak, with an underwood of beech. Their origin dates back to that terrible time in Germany, the Thirty Years' War. Happy is Great Britain because it never had a thirty years' war. Germany to this day is a poor country, and it is a poor country to a great extent because it was devastated from one end to the other between 1618 and 1648. Before that war the cattle in the fertile valleys that surround the Spessart had been in the habit of making the higher parts of these hills their high-level grazing-grounds during summer. These lands were to a large extent stocked with open oak woods, with excellent pasture under the scattered trees. The woods could not fill up by self-sown seedlings, because the cattle trod down or nibbled the young oaks. But during the Thirty Years' War the cattle were slaughtered or driven away, and the result was, that when the first mast year came round large masses of acorns were shed, and the ground got covered with young growth of oaks. That

is the origin of these beautiful oak woods, of which there are 1000 acres in one continuous block on the north face of the Geiersberg, the highest point of the Spessart. Under the old trees a great deal of beech has sprung up naturally, and in a portion of the area beech underwood has been sown and planted.

What I wanted to say regarding the management of the oak in the Spessart is this: In all valleys which descend from this mountain range are saw-mills, places where staves for wine casks are split, and other wood-working establishments. The demand for first-class oak timber is steadily increasing, and as the Spessart supply is not sufficient to satisfy this demand, timber from other parts of Germany and from Slavonia is brought to these saw-mills in large quantities, to be cut up. The Spessart oak, however, is the basis of this industry, which in these localities would come to an end if that source of supply were exhausted. Hence the Government of Bavaria have long ago decided to spread the cutting of the mature oaks in the Spessart over as long a time as possible, so as to maintain this source of wealth for the benefit of the country. The old oak trees mentioned above, as having sprung up after the Thirty Years' War, which are now about two hundred and fifty years old, will, under this arrangement, not be cut until they are well over three hundred years old. Until that time arrives the trees of greater age will be cut, large numbers of which stand scattered in the beech woods. At the age of two hundred and fifty years the annual rings in the timber are barely visible, and the increment is insignificant, in some trees, indeed, it may be more than outweighed by the deterioration of the timber. This is a case in which the increment of the standing crop had long ago fallen below the rate of interest yielded by Government securities.

Year after year, therefore, the Government of Bavaria deliberately sacrifices a very large sum of money, which might be saved, if, instead of letting these old trees stand, they were cut, and the proceeds devoted to the redemption of a portion of the national debt of the country. On this question all parties in the Parliament of the kingdom are unanimous. They unhesitatingly approve of the present system, which is dictated by a due regard for the future wellbeing of the country, but which is not at all in accordance with purely commercial principles.

But I fear that the management of the Spessart may be condemned by you on other grounds. The glass-works have long

ere this ceased to exist, and you will ask: How is the beech wood utilised? The oak sells at two to three shillings per cubic foot, while the beech only fetches two to three pence. And it would not even sell at this rate if large factories had not been established near the Spessart, in which the beech wood is subjected to dry distillation. We imagine that the vinegar we have on our table is made at the brewery, or, better still, is from the vineyard. No such thing! It is all produced by the dry distillation of beech wood in many parts of Germany. Do not, however, please forget that the excellent quality of the Spessart oak timber is due to a great extent to the presence of the beech in the same forests.

There is a great variety of mixed woods. *First*, woods which consist of trees which behave differently with regard to light, such as oak and beech, Scots pine and beech, and to these I will add oak and silver fir. On the western edge of the Schwarzwald are magnificent woods, in which oak forms the upper and silver fir the lower story. You ask how is the silver fir utilised? We expect that the paper-pulp manufacturers will come to our aid, and will take the poles of the silver fir which form the under wood, so that afterwards the oak may be regenerated naturally without much expense. We, *secondly*, have mixed woods where the trees composing them are different in a different respect. You know that the spruce is very shallow-rooted. Its roots are near the surface, and that explains the great liability of pure Spruce forests to be thrown down by the wind. You also know that the Scots pine sends its roots much deeper down, and therefore it has been found that mixed woods of spruce and Scots pine are in places—of course the soil must be suitable—excellent, because, while the spruce gets its nourishment from the surface layer of soil, the Scots pine sends its roots deeper down.

You will ask how pure woods of oak and of Scots pine may be converted into mixed woods. An excellent system has been gradually developed in Germany. When the wood is in the stage of large poles, and about forty years old, a heavy thinning is made, and then an underwood of the beech is introduced by sowing or planting. The effect of this operation is most beneficial. Under the shade of the beech the ground is kept moist and loose, and is fertilised by the fall of the beech leaves. The effect of this, as well as of the thinning, is to stimulate the growth of the oak and Scots pine. Heavy and valuable timber is thus produced in less time than could otherwise be possible.